Identification and Reconstruction of Fission Fragments for Proton-Induced Fission of ^{208}Pb at 500 MeV in Inverse Kinematics

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Spallation reactions have interest for a wide range of applications as neutron sources in material science or nuclear technology (ADS) and also make possible the production of intense Radioactive Nuclear Beams. In astrophysics, these reactions play an important role to interpret the abundances of medium-mass nuclei and actinides in the universe. Moreover, the fission is one of the most complex phenomena that has not a clear theoretical description. In this context, the measurement of the fission fragment distributions in the spallation energy domain makes possible to investigate some fundamental questions connected to the fission dynamics as the dissipation and transient time effects. In this report, we present for the first time the mass (A) and atomic (Z) numbers of both fission fragments measured in inverse kinematics for proton-induced fission of ^{208}Pb at 500 MeV.

The experiment [1] was performed at the ALADIN-LAND cave at GSI. The beam identification was done by an ionization chamber (MUSIC) and its position on the liquid hydrogen target was determined by a time-projection chamber (TPC). Fission events were identified by a high-resolution double ionization chamber (Twin MUSIC) [2], which provided an unambiguous determination of the atomic number of both fission fragments. Moreover, an accurate tracking obtained using Multi-Wire Proportional Counters (MWPC), the Twin MUSIC drift time and the high-resolution Time-of-Flight (ToF) [3] measurement allowed us to determine the fission fragment masses from their bending through the ALADIN dipole.

The reconstruction of the fission fragments was performed with the help of a GEANT4 simulation [4], which reproduce the full detection setup and the dipole magnetic field. In this case, we have used a constant magnetic field around 1.6 T. For the tracking, the atomic number measured by the Twin MUSIC and the polar and azimuthal angles at the entrance of the dipole obtained with the positions measured in the TPC, MWPC and Twin MUSIC are used as an input in the simulation. For each event, we simulate different trajectories covering the expected Bρ range and then we look for the correlation between the simulated Bρ and the horizontal position behind the dipole, which is also checked for the simulated flight path length. Using this method we have found third-order and second-order correlations for the Bρ and flight path length, respectively. These correlations allow to reconstruct the experimental Bρ and the flight path length which, together with the ToF and the Z, give access to the mass number for each fragment.

The reconstruction results are shown in Fig. 1, representing the mass number dependence on the nuclear charge. The calibration in mass and charge was performed by using a previous FRS measurement [5] and maximum charge of the fissioning system (Z_1+Z_2=83). As can be seen in the figure the reconstruction allows a clear identification for all fission fragments. Furthermore, in the inset of the figure we show the mass distribution for the nuclear charge Z=40 where the mass resolution is around 0.63 FWHM.

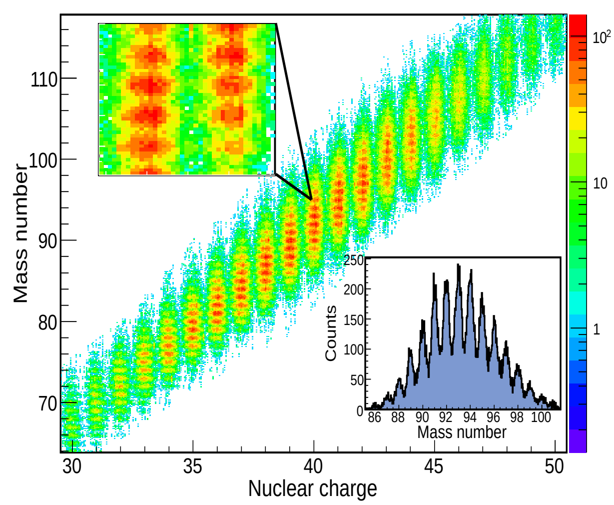

Figure 1: Identification in mass number and nuclear charge for ^{208}Pb (500A MeV)+p. In the inset of the figure we show the mass distribution for nuclear charge Z=40.

References

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